

NIOSH PPT Research to Support Strategic Goal #2: Reduce Exposure to Dermal Hazards

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NIOSH PPT Program Objectives for Strategic Goal #2

- 1. Improve chemical/barrier protective clothing testing and use practices to reduce worker exposure to chemical dermal hazards**
- 2. Improve emergency responder protective clothing to reduce exposure to thermal, biological, and chemical dermal hazards**
- 3. Investigate physiological and ergonomic impact of protective ensembles on individual wearers in affecting worker exposure to dermal hazards**

Organization/Staffing/Funding

- **This strategic goal supported by multiple divisions & locations within NIOSH**
- **NPPTL is the lead division for this strategic goal**
- **Current NIOSH PPT portfolio**
 - Consists of 11+ research projects, including 3 with external funding support
 - Supported by diverse range of 10+ scientists, engineers, physiologists, and medical staff
 - ~\$1 Million in funding in FY07 and FY08

Improve Chemical/Barrier Protective Clothing Testing and Use Practices to Reduce Worker Exposure to Chemical Dermal Hazards

- **It has been estimated that more than 13 million workers in the US are potentially exposed to chemicals that can be absorbed by the skin**
- **Protective clothing acts as a barrier to prevent the hazard from reaching the skin**
- **Research is needed to improve the way testing is done and protective clothing used to increase protection and/or reduce burden**
- **Four current research projects**

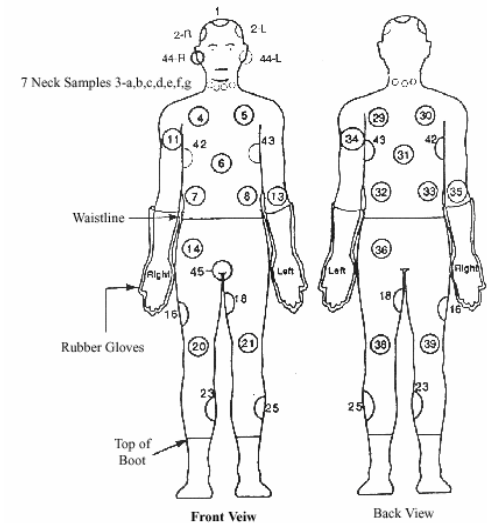
Chemical Protective Clothing Decontamination Efficacy

- **Goal** – develop suitable methods for CPC decontamination
- **Background** – non-disposable CPC is expensive and repeated use without effective decontamination may result in secondary exposure
- **Approaches** – heat extraction, detergent, and self-decontamination
- **Key finding** – some CPC materials can be re-used multiple times after decontamination, but chemical resistance and material degradation should both be carefully investigated

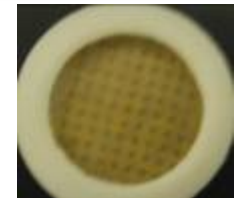


PPE Ensemble Test Methods

- **Goal** – develop magnetic passive aerosol sampler (MPAS) prototypes that can be used for measuring particle penetration through protective clothing
- **Background** – current testing based on active filtration principles, which may overestimate the particle penetration due to additional driving force
- **Current status** – MPAS prototypes are promising for man in simulant testing (aerosol-MIST)

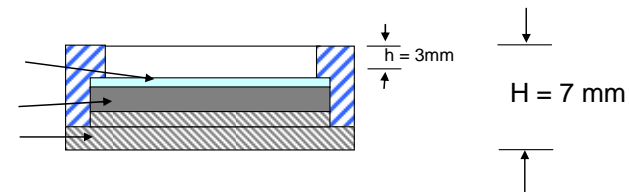


Top View



Magnets underneath the PVC film

PVC Film
Magnets
Support



Nanoparticle Penetration through Protective Clothing

- **Goals** – investigate air flow driven penetration of nanoparticles through non-woven materials used in protective clothing
- **Background** – speculated that penetration of nanoparticles through clothing is likely to be even greater than for larger particles
- **Literature survey** – some fabric swatches behave like filter media and particle penetration is driven by pressure differences and is a function of the air permeability of the fabric
- **Current status** – FY09 new start funded by the NIOSH nanotechnology program

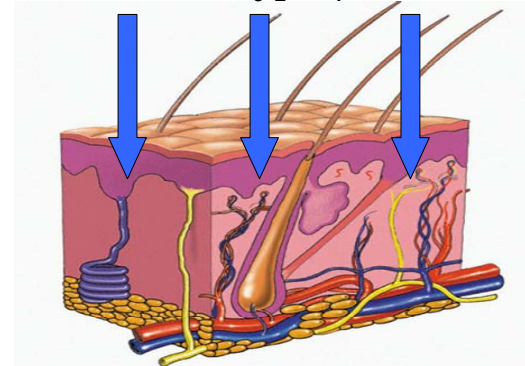
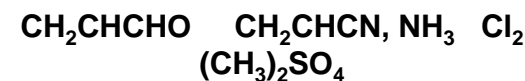


Photo obtained from Health hazard evaluation report: HETA-2005-0291-3025, Methner-MM; Birch-ME; Evans-D; Hoover-MD



Risk Based Permeation Criteria

- Part of a larger project funded by TSWG and managed by IPP, Inc.
- NPPTL primary objective – develop cumulative permeation procedures for the evaluation of protective clothing material barrier performance against toxic industrial chemicals (TICs)
- Background – current selection criteria do not account for specific toxicity and skin effects of TICs, which results in ensembles that are over designed and create undue wearer stress
- Current status – new project for FY08



Skin Permeation Model

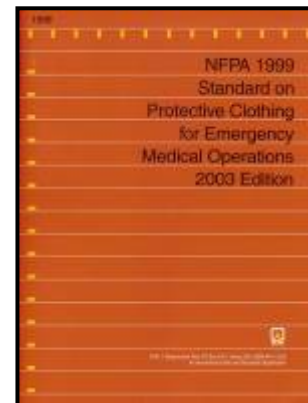


Improve Emergency Responder Protective Clothing to Reduce Exposure to Thermal, Biological, and Chemical Dermal Hazards

- **Estimated 1.5 million first responders (Fire, EMS, Law) rely on PPE as their last line of defense**
- **Protective clothing acts as a barrier to prevent the CBRN and thermal hazards from harming the skin**
- **PPT available for the responder community often lack appropriate test methods and standards based on quality science**
- **Three current research projects**

Improved Criteria for Emergency Medical Protective Clothing

- **Goal** – establish performance criteria for protective clothing and equipment used by emergency medical personnel
- **Background** – mixed industry response to 2003 edition of NFPA 1999 because of conflicting or inappropriate criteria
- **Approach** – obtained end-user input and conducted testing on currently available equipment to determine criteria for revised standard
- **Key finding** – criteria in 2008 edition of NFPA 1999 better match end user expectations and use practices



Improved Lab Preconditioning Methods to Address PPE Durability

- **Goal - develop appropriate preconditioning methods to better simulate actual wear conditions consistent with expected exposures and service life**
- **Background – current criteria for barrier material performance are intended to demonstrate protection over the expected service life, but the lack of scientific studies may result in inappropriate tradeoffs that do not balance protection and the stress-related impact of clothing on wearers**
- **Current status – contract awarded to IPP and peer-review will be initiated in March**





Stored Thermal Energy in Fire Fighter Protective Garments

- Current project activities are part of a multi-organizational project funded by a DHS Fire Grant through the NFPA Research Foundation
- NPPTL role - manage variability studies between test laboratories using the previously developed stored thermal energy test apparatus (funded by NPPTL)
- Background – significant numbers of fire fighter burn injuries occur when energy stored within the layers of the protective equipment are suddenly transferred to the skin through compression of the layers and current standards do not adequately evaluate the risk caused by stored energy
- Current status – data collection has been initiated

NIST



Investigate Physiological and Ergonomic Impact of Protective Ensembles on Individual Wearers in Affecting Worker Exposure to Dermal Hazards

- **PPE designed to offer dermal protection often presents physiological/ergonomic burdens (e.g., restricted movement, heat stress, etc.) to the user**
- **Research is needed to better understand the relationships between new technologies for PPE and burden and then to investigate mitigation strategies**
- **Four current research projects**



Next Generation Structural Fire Fighting PPE – Project HEROES™



- Part of a larger project funded by TSWG and managed by IAFF
- NPPTL primary role – physiological and ergonomic testing of Project HEROES prototype ensemble
- Approach – compared Project HEROES prototype (PE) to standard ensemble (SE)
- Key findings –PE does not adversely affect the wearer's overall functional mobility, but did increase thermal stress compared to the SE



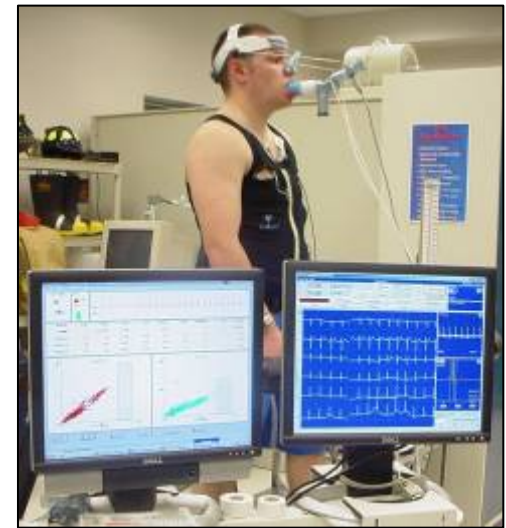
Physiological Models and Countermeasures

- **Goals** – develop protocols to assess the physiological burden of PPE ensembles and investigate physiological countermeasures
- **Background** – overexertion and heat stress are among the most common causes of firefighter injuries and deaths
- **Approach** – transition Project HEROES protocol to ASTM std, initiated research on sensor vests, and cooling systems
- **Current status** – ASTM std published in 2007; research in progress on sensor vests and cooling systems



Correlation of Physiological Data with Total Heat Loss (THL) Test

- **Goal** – investigate physiological basis for setting THL values in future PPE performance standards
- **Background** – THL performance criteria are used in several NFPA standards to estimate heat stress levels caused by turnout gear composites
- **Planned approach** – subjects wearing PPE ensembles with different THL values will be exercised at various work rates to correlate THL values with physiological variables (core/skin body temperature, heart rate, etc.)
- **Current status** – protocol will be developed in FY08 and submitted for external peer-review



Biomechanical and Physiological Study of Firefighter Boots

- **Goal** – determine the effect of boot weight and design on firefighters' biomechanical and physiological responses
- **Approach** – 50 firefighters will be recruited and tested while performing several simulated firefighting tasks in the laboratory. The study will evaluate the effects of boot weight and material (rubber versus leather) on male and female firefighters' oxygen consumption, joint loading, dynamic balance, and gait characteristics
- **Current status** – data collection nearly completed; interim findings presented to NFPA in 2007

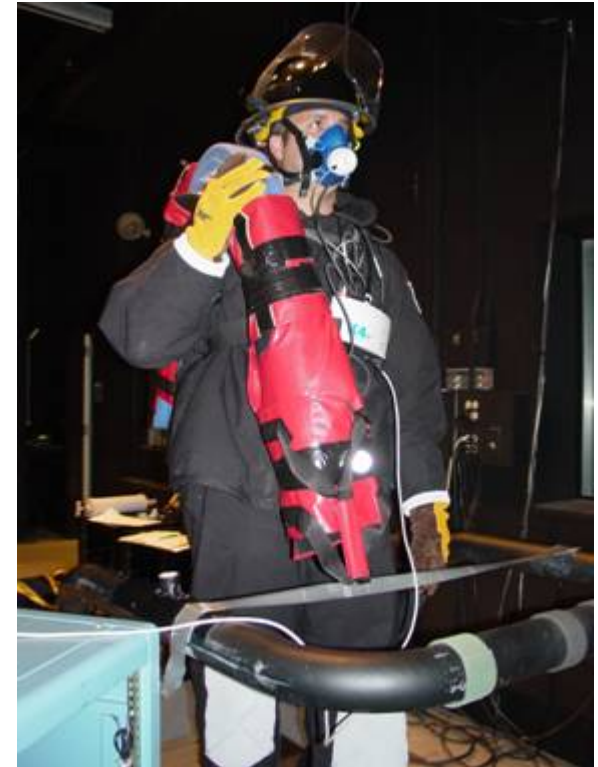


Photo taken from Turner and Chiou presentation at the meeting of the NFPA Technical Committee on Structural and Proximity Fire Fighting Protective Clothing and Equipment, Portland, ME, July 9 – 10, 2007

Summary

- **NIOSH PPT program includes a diverse range of research projects addressing current needs in providing dermal protection to workers (strategic goal #2)**
 - 11 research projects covering 3 objectives
- **Integration with consensus standards organizations has resulted in the transition of NIOSH research into practice**
 - MOUs with ASTM F23 and NFPA
 - ASTM F23 test methods (physiology, MIST)
 - NFPA (1999, 1971, 1994)
- **Research portfolio is expanding to address emerging hazards such as dermal exposure to nanomaterials**

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